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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B. TECH (HONOURS) DEGREE EXAMINATION, DECEMBER 2017

Course Code: CH367

Course Name: NUMERICAL METHODS FOR PROCESS ENGINEERS (CH)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Air at 25^0C and 1 atm flows through a 4 mm diameter tube with an average velocity of 25 m/s. The roughness is ε = 0.0015 mm. Calculate the friction factor using the Colebrook equation given by $\frac{1}{\sqrt{f}} = -2.0log\left(\frac{\varepsilon/D}{3.7} + \frac{2.51}{Re\sqrt{f}}\right)$ applying Newton-Raphson method. Density of air at 25^0C and 1 atm is 1.23 kg/m^3 and the viscosity is 1.79 x 10^{-5} kg/(m-s). (8)

b) Find the root of the equation $f(x) = cosx - xe^x = 0$ using Chebyshev method, correct to four decimal places, taking the initial approximation as 1.0 (7)

2 a) Define *absolute error* and *relative error*. How will you define the relative error in an iterative computation, where the error is updated in every iteration? (2.5)

b) Generate the equation to determine the real root of an equation $f(x) = 0$ by the method of false position. (5)

c) Find the dominant eigen value of the given matrix using power method, correct to four significant figures: (7.5)

$$\begin{bmatrix} 1 & 2 & 4 \\ 3 & 1 & 2 \\ 4 & 2 & 5 \end{bmatrix}$$

3 a) Solve by Gauss Elimination method: (8)

$$10x - 7y + 3z + 5u = 6$$
$$-6x + 8y - z - 4u = 5$$
$$3x + y + 4z + 11u = 2$$
$$5x - 9y - 2z + 4u = 7$$

b) Using Jacobi iteration, solve the system of equations: (7)

$$4x_1 + x_2 + x_3 = 2$$
$$x_1 + 5x_2 + 2x_3 = -6$$
$$x_1 + 2x_2 + 3x_3 = -4$$

PART B

Answer any two full questions, each carries 15 marks.

4 a) The vapour pressure of water increases with temperature as follows: (8)

T(0C)	pv (mm Hg)
30	31.8
40	55.3
50	92.5
60	149.4

Derive the third-order interpolating polynomial using the forward difference formula.

b) Show that $\Delta^3 y_i = y_{i+3} - 3y_{i+2} + 3y_{i+1} - y_i$ (7)

5 a) Given $log654 = 2.8156, log658 = 2.8182, log659 = 2.8189,\ log661 = 2.8202;$ find the value of $log656$ using Lagrange's formula. (7.5)

b) A slider in a machine moves along a fixed straight rod. Its distance **x** cm along the rod is given below for various values of the time **t** seconds. Find the velocity of the slider and its acceleration when **t**=0.3 second, using the concept of numerical differentiation: (7.5)

t =	0	0.1	0.2	0.3	0.4	0.5	0.6
x =	30.13	31.62	32.87	33.64	33.95	33.81	33.24

6 a) Evaluate the integral $I = \int_0^2 \frac{dx}{3+4x}$ using Gauss-Legendre two-point formula (8)

b) Obtain a generalized trapezoidal rule of the form (7)

$$\int_{x_0}^{x_1} f(x)dx = \frac{h}{2}(f_0 + f_1) + ph^2(f_0' - f_1')$$

Find the constant **p** and the error term.

PART C

Answer any two full questions, each carries 20 marks.

7 a) Solve the differential equation $\frac{dy}{dx} = x^2 y$ with initial condition $y(x = 0) = 1$ using Euler's method. Find $y(x = 0.5)$ using stepsize h=0.1 (10)

b) Find y(0.8) and y(1) by using Milne's method given that y(0.2) = 0.02, y(0.4) = 0.0795 and y(0.6) = 0.1762, for the differential equation $\frac{dy}{dx} = x - y^2$, y(0)=0. (10)

8 a) Explain the graphical interpretation of Runge-Kutta family of methods for the solution of differential equations. (10)

b) The following second-order differential equation describes the concentration profile inside a porous catalyst pellet when diffusion and chemical reaction take place simultaneously. (10)

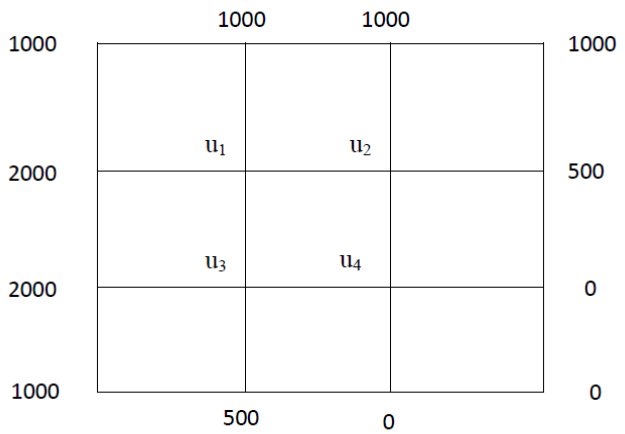
$$\frac{d^2C}{dr^2} + \frac{2}{r}\frac{dC}{dr} - \alpha C = 0$$

Boundary Condition 1: $\frac{dC}{dr} = 0$, at $r = 0$

Boundary Condition 2: $C = C_s$, at $r = R$

Solve the problem by finite difference method, taking $R = 0.003$, $\alpha = 4\ X\ 10^6\ and\ C_s = 0.1$

9 a) Given the values of u(x,y) on the boundary of the square in the figure given below, evaluate the function u(x,y) satisfying the Laplace equation $\nabla^2 u = 0$ at the pivotal points of the figure(u_1, u_2, u_3 and u_4). (10)



b) Solve the heat equation $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$ subject to the conditions $u(0,t) = u(1,t) = 0$ and $u(x,0) = 2x\ for\ 0 \le x \le 0.5$ and $(x,0) = 2(1-x)\ for\ 0.5 \le x \le 1$. Take $h = 0.25\ and\ k$ according to Bandre-Schmidt equation. (10)

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